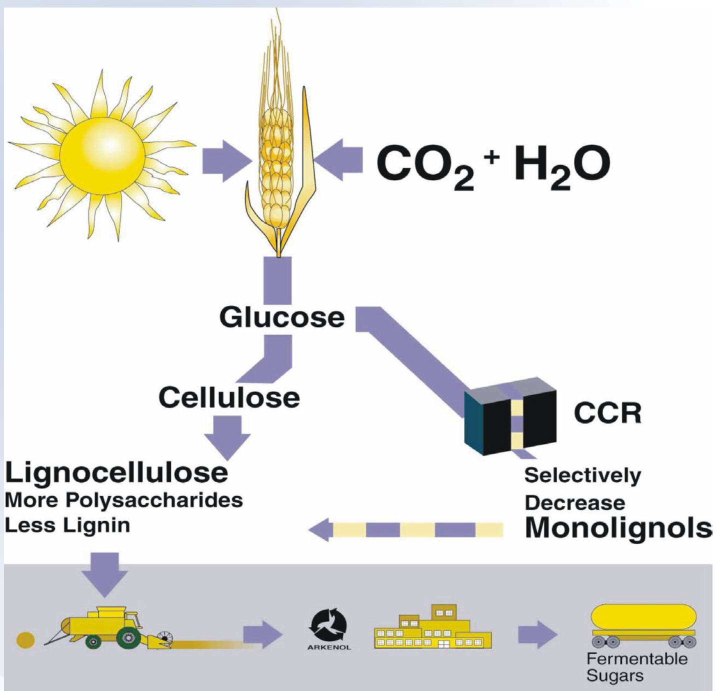
Chemicals and Fuels from Whole-Crop Utilization

World energy consumption is projected to increase from 95 quads in 1998 to 121 quads in 2020. The effects of this increase will be magnified by a decrease in U.S. oil production, nuclear power generation, and hydropower generation. Biomass from crop residues is a very promising alternative to petroleum as a feedstock for energy and chemical production. Crop residues that are currently wastes from agricultural and forest product operations amount to more than 1.8 billion tons world-wide. The Chemicals and Fuels from Whole Crop Utilization Program is researching a suite of technologies that will enable whole-crop utilization for food, feed, fiber, energy, and value-added products.



Progress

In collaboration with other Department of Energy national laboratories, industry, and university researchers, INL personnel are developing small-grain crop strains, advanced grain harvesting equipment, and bioprocessing systems for converting grain straw into added-value materials. Renewable feedstocks such as wheat straw are used to economically produce chemicals. Naturally occurring microorganisms can convert these low-value residuals into building blocks for use in forming industrial chemicals. Bioconversion of straw into its basic molecules, e.g., glucose from cellulose or xylose from hemicelluloses, allows their use to make target chemical precursors for production of plastics and resins, textiles, adhesives, films and coatings, solvents, cosmetics, food additives, medical materials - all of which now come from crude oil. Thus today's wheat straw, largely a waste material, is the focus of whole crop utilization for food, feed, fiber, energy, and chemicals from crop residuals, i.e., tomorrow's feedstock for high-value materials.

INL researchers have completed an engineering analysis for producing commodity chemicals from renewable feedstocks; developed a proprietary bioprocess to synthesize a plastics precursor from wet-milled cereal feedstocks; and selected wheat plant improvement options for straw production with enhanced cellulose content. They have also applied auto steering software and 'hitch-pin' sensor characterization for crop production and harvesting, including remote sensing tools for irrigation and chemigation; modified bacterial cells by amplifying the enzymatic pathways for biochemical production; and have used directed evolution and screening techniques for collecting enzymes and selecting extremophilic

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Science

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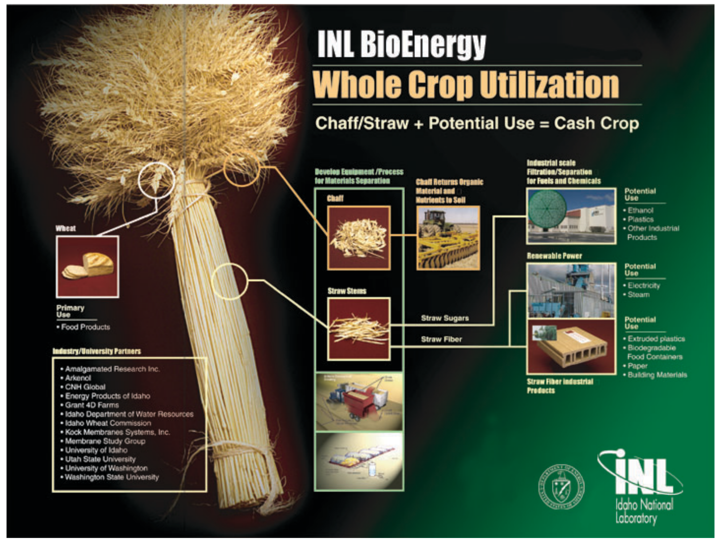
microbes from Yellowstone National Park, the Arctic, and the Pacific Ocean.



Selected Publications/ Presentations/Patents

D.N. Thompson and M.A. Hamilton, "Production of Bacterial Cellulose from Alternative Feedstocks," *Applied Biochemistry and Biotechnology*, Vol. 91–93, 2001 (in press).

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J.K. Polman, G.A. Bala, and P. St. Clair, "Models for the Biological Production of Glycerol and Biosurfactants from Potato Processing Industry Residuals," *Applied Biochemistry and Biotechnology*, Vol. 51/52, 1995, pp. 511–518.

J.K. Polman, "Review and Analysis of Renewable Feedstocks for the Production of Commodity Chemicals," *Applied Biochemistry and Biotechnology,* Vol. 45/46, 1994, pp. 709–722.

S.A. Leeper and G.F. Andrews, "A Critical Review and Evaluation of Bioproduction of Organic Chemicals," *Applied Biochemistry and Biotechnology,* Vol. 28/29, 1991, pp. 499–511.

S.A. Leeper, T.E. Ward, and G.F. Andrews, "Production of Organic Chemicals via Bioconversion: a Review of the Potential," INEEL Report EGG-2645, 1991.

05-GA50193-52